

10/520995

1 "Connector"

2

3 This invention relates to an electrical connector,  
4 particularly but not exclusively for use in  
5 difficult to and/or out of reach locations.

6

7 Electrical connectors are used in a variety of  
8 domestic and industrial Applications. A number of  
9 different connectors are known and these vary from  
10 application to application, a 3-pin plug and wall  
11 socket is a typical example.

12

13 There are two popular types of connector for  
14 connecting light bulbs to a socket; a thread  
15 connection and a bayonet connection. For the thread  
16 connection, the bulb thread is rotationally aligned  
17 with a thread of the socket and then screwed into  
18 the socket allowing respective electric terminals on  
19 the bulb and socket to connect.

20

21 The bayonet connection has pins which extend  
22 radially from the bulb. The pins are aligned with  
23 apertures in a circumferentially extending rim of

1 the socket and inserted therethrough against action  
2 of a spring in the socket and so to allow respective  
3 terminals on the bulb and socket to electrically  
4 connect. The bulb is then turned so that the pins  
5 move into small recesses in the rim and are no  
6 longer aligned with the apertures. The action of  
7 the spring engages the pins with an edge of the  
8 recesses to hold the bulb in the socket and maintain  
9 the electrical connection.

10

11 Although these connectors are generally competent,  
12 they can be difficult to secure and release,  
13 particularly in out of reach places such as sockets  
14 suspended from the ceiling.

15

16 Moreover, some current light sockets are hazardous  
17 because they contain exposed live electrical  
18 contacts and are replaced in such out of reach  
19 environments when it is often dark because the light  
20 is inoperable at that moment. Inadvertent contact  
21 with exposed electrical contacts can have  
22 potentially fatal consequences.

23

24 A connector for a cordless kettle is described in  
25 US5971810 the disclosure of which is incorporated  
26 herein by reference. This connector, shown in Figs.  
27 1a - 1c allow the connection between a male part 20  
28 and female part 50 of the connector regardless of  
29 relative rotational orientation.

30

1 According to the present invention there is provided  
2 an electrical connector comprising a male part and a  
3 female part for engagement therewith;  
4 the male part comprising a first terminal  
5 having a circular cross section and a second  
6 terminal;  
7 the female part comprising engaging means to  
8 engage said terminals;  
9 wherein the male and female parts each comprise a  
10 magnetic portion adapted to attract the parts  
11 together to form an electrical connection.  
12  
13 Preferably, the connector comprises magnetic  
14 misconnection means to prevent the male and female  
15 parts from connecting in a non-concentric position.  
16  
17 Preferably, the magnetic field or flux emitted from  
18 at least one of the magnetic portions extends beyond  
19 the magnetic misconnection means to attract the  
20 parts together to form an electrical connection.  
21  
22 Preferably, the first and second terminals are  
23 concentric.  
24  
25 Preferably, the second terminal is a pin terminal.  
26 Preferably, the second terminal has a circular cross  
27 section. Preferably, the first terminal is an  
28 annular terminal.  
29  
30 Preferably, the male or female part is attached to  
31 pendent means, more preferably, the female part is  
32 attached to the pendent means.

1 Preferably, the parts can engage with each other in  
2 any relative rotational orientation.

3

4 Preferably, the magnetic portions have a circular  
5 cross section, and are preferably in the form of an  
6 annular ring.

7

8 Preferably, at least one magnetic portion is  
9 provided in a recessed portion to prevent the  
10 magnets from connecting in a non-concentric  
11 position. Preferably, one of the male and female  
12 parts comprise walls extending away from its  
13 magnetic portion, the walls being adapted to prevent  
14 the male and female parts from connecting in a non-  
15 concentric position. Preferably, the male part  
16 comprises the walls.

17

18 It will be appreciated by the skilled person that a  
19 substantially concentric position is not to be  
20 regarded as a non-concentric position.

21

22 Preferably, the parts seek and locate with each  
23 other when brought into the vicinity of each other.

24

25 Preferably, the parts are adapted to be attracted  
26 together to form an electrical connection when they  
27 are between 1cm and 30cm apart.

28

29 More preferably, the parts are adapted to be  
30 attracted together to form an electrical connection  
31 when they are between 2cm and 30cm apart, although  
32 the parts may be adapted to be attracted together to

1 form an electrical connection when they are between  
2 5cm and 30cm apart. Indeed the parts may be adapted  
3 to be attracted together to form an electrical  
4 connection at greater distances.

5

6 Preferably, the terminals are male terminals.

7

8 Preferably, the first terminal is a neutral terminal  
9 and the second terminal is a live terminal and the  
10 engaging means of the female part may comprise  
11 respective female neutral and live terminals.

12

13 Preferably, the neutral and live terminals of the  
14 female part are enclosed. By 'enclosed' it is  
15 intended to mean that they are generally  
16 inaccessible except to the male terminals. This may  
17 be achieved by providing narrow apertures  
18 (preferably less than 3mm wide) within the female  
19 part or providing a shutter means.

20

21 Optionally a male earth terminal may be provided.  
22 Preferably, the earth terminal has a circular cross  
23 section and is concentric with the first and second  
24 terminals. More preferably, the male earth terminal  
25 has a greater diameter than the other male  
26 terminals.

27

28 Preferably, the female portion has a  
29 circumferentially projecting portion. Preferably  
30 the said projecting portion has an aperture therein  
31 to receive the first male terminal. More preferably

1 the projecting portion also has an annular groove  
2 therein to receive the second male terminal.

3

4 Preferably, the projecting portion is adapted to  
5 extend into or around the male part, preferably, the  
6 male earth terminal. More preferably, the diameter  
7 of the projecting portion allows it to pivot in the  
8 male part or the male earth terminal to a limited  
9 extent. Even more preferably, the projecting  
10 portion comprises a lip which is adapted to closely  
11 fit with the male part or male earth terminal.  
12 Preferably therefore, the rest of the projecting  
13 portion comprises a smaller outer diameter than an  
14 outer diameter of the lip.

15

16 Preferably, the projecting portion comprises a boss.

17

18 Preferably, the magnetic portion of the female part  
19 has a magnetic field which extends beyond the  
20 projecting portion to attract the parts together to  
21 form an electrical connection.

22

23 A corresponding female earth terminal may extend  
24 through the projecting portion of the female part.

25

26 Alternatively the first terminal is a pin terminal  
27 and the second terminal can be a leaf terminal. In  
28 alternative embodiments the pin terminal may be an  
29 earth terminal. Also, a resiliently mounted shutter  
30 may be provided on the female part.

31

1 Preferably, the male terminals are adapted to engage  
2 with the female terminals so that in use, the earth  
3 connection is the first to be made, then the neutral  
4 connection and lastly the live connection.

5

6 Preferably, the male terminals are adapted to  
7 disengage with the female terminals in the order:  
8 live first, neutral second, earth last.

9

10 Preferably, the female live and neutral terminals  
11 comprise a means to reduce the possibility of arcing  
12 during connection and disconnection; for example the  
13 female terminals may be coated with silver or silver  
14 pads.

15

16 Preferably, the male and/or female terminals are  
17 resilient in order such that they will maintain a  
18 connection with the corresponding female/male  
19 terminals. More preferably, the female terminals are  
20 resilient.

21

22 Preferably, at least one part comprises guide means  
23 to guide the parts together. The guide means may be  
24 in the form of a tapered face.

25

26 Preferably, the magnetic portions comprise neodymium  
27 or samarium cobalt based rare-earth permanent  
28 magnets such as a NdFeB (neodymium-iron-boron) or  
29  $\text{SmCo}_5$  or  $\text{Sm}_2\text{Co}_{17}$  (samarium cobalt) magnets.

30

31 Preferably, the strength of the magnet is sufficient  
32 to attract the parts of the connector together. For

1 example, where at least one part of the connector is  
2 connected to the pendent means and the other part of  
3 the connector is brought within 8cm of the first  
4 part, the parts will preferably attract each other,  
5 and move towards each other and connect. Optionally,  
6 even stronger magnets may be used so that the parts  
7 can attract each other at distances of 12-15cm.

8

9 The strength grade may be 30 although other grades  
10 may be used. The magnetic portions may be exposed  
11 on the outside of the parts or may be provided  
12 within a body of the parts.

13

14 Preferably, the magnetic portions are protected by  
15 at least one shield and may be protected by  
16 respective shields, such that when the male and  
17 female parts are connected together, the shield(s)  
18 is interposed between the magnetic portions. Thus,  
19 when the connector is engaged, the magnets do not  
20 come into direct physical contact.

21

22 Preferably, at least one of the magnetic portions is  
23 provided as a replaceable cartridge.

24

25 More preferably, an aperture is provided in at least  
26 one of the male and female parts through which the  
27 magnetic portions may be removed and replaced.

28

29 Alternatively, a removable cap may be provided on  
30 the male or female parts to allow the magnetic  
31 portions to be removed and replaced.

32

1 The connector may be used to connect electrical  
2 appliances to mains electrical supplies.

3

4 Alternatively one part of the connector may further  
5 comprise a standard bulb fitting at one end, such as  
6 a screw or bayonet, so that a bulb can be placed in  
7 that one part before the connection is made, thus  
8 allowing easier connection of the bulb to a  
9 difficult to reach or out of reach socket since the  
10 parts attract one another.

11

12 Embodiments of the present invention will now be  
13 described by way of example only with reference to  
14 the accompanying drawings wherein-

15 Fig. 1a is an upper perspective view of a known  
16 connector in its disconnected position;

17 Fig. 1b is a lower perspective view of the  
18 known connector of Fig. 1a;

19 Fig. 1c is an upper perspective view of the  
20 known connector of Fig. 1a but in its connected  
21 position;

22 Fig. 2a is a side view of a first embodiment of  
23 a connector in accordance with the present  
24 invention, in a disconnected position with an  
25 attached light bulb;

26 Fig. 2b is a plan view of a female part of the  
27 connector of Fig. 2a;

28 Fig. 2c is a plan view of a male part of the  
29 connector of Fig. 2a;

30 Fig. 2d is a partially cut-away perspective  
31 view of the female part of Fig. 2b;

1        Fig. 2e is a partially cut-away perspective  
2        view of the male part of Fig. 2c;  
3        Fig. 2f is a perspective view of the female  
4        part of Fig. 2b;  
5        Fig. 2g is a perspective view of the male part  
6        of Fig. 2c;  
7        Fig. 3 is a side view of the connector of Fig.  
8        2a but in its connected position;  
9        Fig. 4a is a side sectional view of a second  
10       embodiment of a connector in accordance with  
11       the present invention;  
12       Fig. 4b is a side view of the connector of Fig.  
13       4a;  
14       Fig. 4c is a plan view of a female part of the  
15       connector of Fig. 4b;  
16       Fig. 4d is a plan view of a male part of the  
17       connector of Fig. 4b;  
18       Fig. 5a is a perspective view of the female  
19       part of Fig. 4c;  
20       Fig. 5b is a perspective view of the male part  
21       of Fig. 4d;  
22       Fig. 5c is a second perspective view of the  
23       male part of Fig. 4d with a portion cut away;  
24       Fig. 6a is a side view of a third embodiment of  
25       a connector in accordance with the present  
26       invention, in its disconnected position with an  
27       attached light bulb;  
28       Fig. 6b is a plan view of a female part of the  
29       connector of Fig. 6a;  
30       Fig. 6c is a perspective view of the female  
31       part of Fig. 6b;

1        Fig. 6d is a partially cut away perspective  
2        view of the female part of Fig. 6b;  
3        Fig. 6e is a partially cut away perspective  
4        view of a male part of the connector of Fig.  
5        6a;  
6        Fig. 6f is a perspective view of the male part  
7        of Fig. 6e;  
8        Fig. 6g is a plan view of the male part of Fig.  
9        6e;  
10       Fig. 7 is a side view of the connector of Fig.  
11       6a but in its connected position;  
12       Fig. 8 is a perspective view of the connector  
13       of Fig. 6a with an attached light bulb;  
14       Fig. 9a is a side sectional view of a fourth  
15       embodiment of a connector in accordance with  
16       the present invention, in its disconnected  
17       position;  
18       Fig. 9b is a side view of the connector of Fig.  
19       9a;  
20       Fig. 9c is a plan view of a female part of the  
21       connector of Fig. 9b;  
22       Fig. 9d is a plan view of a male part of the  
23       connector of Fig. 9b;  
24       Fig. 10 is a side sectional view of the  
25       connector of Fig. 9a but in its connected  
26       position;  
27       Fig. 11 is a side sectional view of the  
28       connector of Fig. 9a showing magnetic  
29       attraction between the male and female parts;  
30       Fig. 12a is a perspective view of the female  
31       part of Fig. 9c;

1        Fig. 12b is a partially cut away perspective  
2        view of the female part of Fig. 9c;  
3        Fig. 12c is a second partially cut away view of  
4        the female part of Fig. 9c;  
5        Fig. 12d is a partially cut away perspective  
6        view of the male part of Fig. 9d;  
7        Fig. 12e is a perspective view of the male part  
8        of Fig. 9d;  
9        Fig. 12f is a second partially cut away view of  
10       the male part of Fig. 9d;  
11       Fig. 13 is an enlarged view of the female part  
12       of the connector of Fig. 12c;  
13       Fig. 14 is a sectional view of a male part of a  
14       fifth embodiment of a connector in accordance  
15       with the present invention;  
16       Fig. 15 is a sectional view of a female part of  
17       the embodiment of Fig. 14;  
18       Fig. 16 is a sectional view of the male and  
19       female parts of the connector of Figs. 14 and  
20       15 in a connected position;  
21       Fig. 17a is a sectional view of a pair of ring  
22       magnets approaching each other;  
23       Fig. 17b is a sectional view of the ring  
24       magnets of Fig. 17a in a concentrically  
25       connected position;  
26       Fig. 18a is a sectional view of a pair of ring  
27       magnets also approaching each other but at a  
28       different angle than the ring magnets of Fig.  
29       17a;  
30       Fig. 18b is a sectional view of the ring  
31       magnets of Fig. 18a in an offset connected  
32       position;

1        Fig. 19 is a further sectional view of a pair  
2        of ring magnets approaching each other;  
3        Figs. 20a-20d are a series of front views  
4        showing the male and female parts of the Fig.  
5        4a connector, connecting with each other;  
6        Figs. 20e-20f are a pair of front views showing  
7        the male and female parts of the Fig. 4a  
8        connector disconnecting from each other;  
9        Fig. 21 is a perspective view of a cartridge  
10       and magnet of the fourth embodiment of the  
11       invention; and  
12       Fig. 22 is a top view of the cartridge and  
13       magnet of Fig. 21.

14

15    A known connector 10 is shown in Figs. 1a-1c and is  
16    disclosed in more detail in US 5,971,810 the  
17    disclosure of which is incorporated herein by  
18    reference. The connector 10 comprises a male part  
19    20 adapted to mate and form an electrical connection  
20    with a female part 50. The male part 20 comprises a  
21    live central pin terminal 21, and first neutral 22  
22    and second earth 23 annular terminals. The female  
23    part comprises a boss 63 which projects from a body  
24    60 of the female part 50, a central aperture 61 for  
25    receiving the pin terminal 21 and an annular recess  
26    62 for receiving the annular terminal 22 of the male  
27    part 20. When connected, as shown in Fig. 1c, the  
28    second annular terminal 23 of the male part 20  
29    locates around the boss 63 and live and neutral  
30    female terminals 51, 52 are located within the  
31    central aperture 61 and annular recess 62  
32    respectively for electrical connection with the

1 corresponding male terminals 21, 22. An earth  
2 terminal 53 is provided through a side wall 64 of  
3 the boss 63 to connect with the annular earth  
4 terminal 23 of the male part 20. All male and female  
5 terminals 21-23, 51-53 are attached to spade  
6 connectors 31-33, 71-73 respectively and in turn to  
7 electrical appliances or powers sources (not shown).

8

9 A first embodiment of a connector 100 in accordance  
10 with the present invention is shown in Fig. 2a. The  
11 connector 100 comprises a male part 120 adapted to  
12 mate and form an electrical connection with a female  
13 part 150. A light bulb 101 is attached to the male  
14 part 120 at the opposite end of the connection with  
15 the female part 150 by any known means, in this  
16 embodiment, by a bayonet fitting 102, and can be  
17 removed and replaced when required by such known  
18 means. The male part 120, shown in plan view in  
19 Fig. 2c, comprises a body 130 having a central pin  
20 terminal 121, and first 122 and second annular  
21 terminals 123. The three terminals 121-123 are  
22 concentric.

23

24 In this embodiment the pin terminal 121 of the male  
25 part 120 is connected to a live terminal 127 of the  
26 standard connector 102 by wire 124 and the first and  
27 second annular terminals 122, 123 to neutral 128 and  
28 earth 129 terminals of the connector 102  
29 respectively, also by wire 125, 126. It will be  
30 appreciated that some light fittings do not have  
31 earth connections and so their inclusion is  
32 optional. The male part 120 includes a tapered

1 surface 140 to facilitate location with the female  
2 part 150.

3

4 The female part 150 is suspended from a ceiling (not  
5 shown) by a pendent or cable 103 and secured to the  
6 cable 103 by a cable clamp 104. The female part  
7 comprises a boss 163 which projects from a body 160,  
8 a central aperture 161 for receiving the pin  
9 terminal 121 and an annular recess 162 for receiving  
10 the first annular terminal 122 of the male part 120.

11

12 The boss 163 has a lip 168 which extends  
13 circumferentially outwards therefrom such that the  
14 diameter of the boss 163 with the lip 168 is greater  
15 than the diameter of the boss 163 without the lip  
16 168. The lip 168 is sized to closely fit with the  
17 second annular terminal 123 and thus helps to align  
18 the parts 120, 150 together. The smaller diameter  
19 of the remaining portion of the boss 163 allows the  
20 parts 120, 150 to connect when they are at an angle  
21 to each other, and for the boss 163 to pivot within  
22 the annular earth terminal 123 into axial alignment  
23 with the male part 120.

24

25 When connected, as shown in Fig. 3, the second  
26 annular terminal 123 of the male part 120 locates  
27 around the boss 163. Female terminals 151, 152 are  
28 located within the central aperture 161 and annular  
29 recess 162 for electrical connection with the  
30 corresponding male annular terminals 121, 122. An  
31 earth terminal 153 is provided through a side wall

1 164 of the boss 163 to connect with the second  
2 (earth) annular terminal 123 of the male part 120.

3

4 The terminals in the female part 150 are spring  
5 loaded to maintain the connection between the  
6 respective male and female terminals and adapted so  
7 that a connection forms between the respective earth  
8 terminals 123, 153 then between the neutral  
9 terminals and then between the live terminals when  
10 the male 120 and female 150 parts are connected.  
11 Conversely, when the connection between the male 120  
12 and female 150 parts is broken, the live terminals  
13 121, 151 are adapted to disengage first, then the  
14 neutral terminals 122, 152 and lastly the earth  
15 terminals 123, 153. This ensures that sparking or  
16 arcing is minimised during connection and  
17 disconnection of the parts of the connector so that  
18 it is safe to use. Also, the male live and neutral  
19 connections are surrounded by the earth terminal 123  
20 which reduces the possibility of electrocution when  
21 connected. The live 151 and neutral 152 terminals  
22 of the female part 150 are also safely enclosed  
23 within the female part 150 in line with British  
24 safety regulations. In order to further reduce the  
25 possibility of arcing during  
26 connection/disconnection of the parts 120, 150; the  
27 live 151 and neutral 152 terminal of the female part  
28 150 are coated with silver or have silver pads.

29

30 A magnetic ring 135 is secured by spring clips (not  
31 shown) or any other suitable means to the male part  
32 120 between the first annular terminal 122 and the

1 second (earth) annular terminal 123. An oppositely  
2 attracting magnetic ring 165 is secured between the  
3 annular recess 162 and an edge 166 of the boss 163  
4 of the female part 150, as shown in Fig. 2f. A  
5 suitable heat resistant glue may also be used to  
6 secure the magnetic rings 135, 165 to the parts 120,  
7 150 although this is less preferred.

8  
9 The magnetic ring 135 is provided in a recessed  
10 portion of the male part 120 such that the boss 163  
11 of the female part 150 must extend into the male  
12 part 120 in order for the magnets to engage. This  
13 prevents the magnets joining in an offset position  
14 and is explained more thoroughly hereinafter.

15  
16 In this embodiment the magnetic rings are annular  
17 rings and around 1.5mm thick and have an outer  
18 diameter of 27mm and a central aperture of diameter  
19 15mm although it will be appreciated that a variety  
20 of sizes may be used. A further embodiment has a  
21 diameter of 28mm and a central aperture of 16mm for  
22 the female part 150. The magnetic rings 135, 165  
23 are powerful enough to attract the parts 120, 150 of  
24 the connector 100 at a distance of up to 8cm. For  
25 stronger magnetic rings, the parts may attract each  
26 other at a distance of up to 12-20cm. However there  
27 is a balance between proximity of location and ease  
28 of separation for different embodiments - extremely  
29 strong magnetic rings that locate one another over  
30 30cm apart would be increasingly difficult to  
31 separate when required. On the other hand, weak  
32 magnetic rings which are easier to separate would

1 require the parts 120, 150 to be offered closer in  
2 order to seek and locate with each other and may not  
3 be powerful enough to maintain the weight of the  
4 male part 120 and attached bulb 101. Therefore the  
5 direction of magnetism is through depth and the  
6 strength grade is preferably 30. The magnetic rings  
7 are preferably made from neodymium or samarium  
8 cobalt based rare earth materials, such as a  
9 neodymium-iron-boron NdFeB known as 'Neo' or  
10 samarium-cobalt,  $\text{SmCo}_5$  or  $\text{Sm}_2\text{Co}_{17}$ . For other  
11 embodiments, for example, those used in industrial  
12 applications, the strength grade may be higher.

13  
14 The Neo and samarium cobalt magnets have excellent  
15 qualities of high remanent magnetisation, high  
16 coercive force and high magnetic energy product and  
17 also the advantages of being easy to process and a  
18 relatively high performance/cost ratio. Neo and  
19 samarium cobalt magnets are especially suitable for  
20 this application because of their small volume,  
21 light weight and high quality. The magnetic rings  
22 are available from Swift Magnets Ltd, Barlborough  
23 UK; Goudsmit magnetics UK Limited of Surrey, United  
24 Kingdom or the Stanford Magnets Company of Aliso  
25 Viejo, California, USA. Alternatively, magnetic  
26 discs instead of magnetic rings may be utilised.

27  
28 In alternative embodiments, magnetic particles can  
29 be mixed with nylon/plastic compound and injection  
30 moulded to the appropriate shape. For example, the  
31 boss 163 of the female connector could be formed  
32 from a mixture of NdFeB and/or SmCo particles and

1 plastic which has been moulded to an appropriate  
2 shape. In such an embodiment, the magnetic  
3 particles are preferably distributed close to the  
4 edge of the boss such that it behaves similar to a  
5 separate boss and magnet attached together such as  
6 the boss 163 and magnet 165.

7.

8 Pole pieces (not shown) may be provided within the  
9 male or female parts behind the magnets 135, 165 to  
10 direct the magnetic attraction more efficiently and  
11 thus aid the location of the parts 120, 150  
12 together. Where pole pieces are used, the magnets  
13 135, 165 may be weaker without reducing the forces  
14 attracting the opposite part. Pole pieces placed at  
15 the side of magnets increase the force of connection  
16 with the opposite part but decrease the distance at  
17 which the parts can attract each other. Therefore,  
18 in preferred embodiments, the pole pieces are not  
19 placed at the side of the magnets as greater  
20 attraction of the parts together is normally  
21 preferred to the strength of the eventual connection  
22 between the parts.

23

24 Optionally, a plastic sheath (not shown) may be  
25 provided over the pin terminal 121 leaving only its  
26 tip exposed for electrical connection with the  
27 female terminal 151. This reduces the possibility  
28 of arcing between the live and neutral terminals  
29 caused by metallic debris. To the same end, a  
30 plastic cone (not shown) may be provided around a  
31 portion of the pin terminal 121, and a tapered wall

1 (not shown) may be provided on the inner face of the  
2 second annular terminal 122.

3

4 Thus, in use, the male part 120 of the connector 100  
5 may be completely detached from the female part 150  
6 and held in an operator's hand in the most  
7 convenient position. In this position, the light  
8 bulb 101 may be inserted into the socket 102 of the  
9 male part 120 so that the live, neutral and earth  
10 (if provided) terminals (not shown) of the bulb 101  
11 connect with the respective terminals 127, 128 and  
12 129 of the bayonet connector 102. The male part 120  
13 with the attached light bulb 101 can then be raised  
14 towards the female part 150. This may be done by  
15 hand or, for example on a telescopic gripping pole  
16 (not shown). When the male 120 and female 150 parts  
17 are within the vicinity of each other the parts 120,  
18 150 will automatically seek each other and form a  
19 connection with each other (as shown in Fig. 3) due  
20 to the magnetic attraction between the magnetic  
21 rings 135, 165 without the need for accurate  
22 alignment of the parts 120, 150 by the operator.  
23 The connection of the magnetic rings 135, 165 also  
24 results in the male terminals 121-123 and the female  
25 terminals 151-153 connecting with each other to form  
26 an electrical connection between the male and female  
27 parts 120, 150. Therefore the current can flow from  
28 a mains supply (not shown) through the cable 103,  
29 through the female part 150, through the connection  
30 formed between the female part 150 and the male part  
31 120, through the male part 120, through the standard  
32 connection 102 and into the bulb 101. The magnetic

1 rings 135, 165 therefore have two distinct  
2 functions, one, to locate the male 120 and female  
3 150 parts together, and two, to hold the parts 120,  
4 150 together.

5  
6 Embodiments of the present invention benefit from  
7 being able to seek and locate the parts together at  
8 a relatively large distance, for example, 8cm or up  
9 to 20cm or more. This is in contrast to some  
10 previous magnetic connectors which must be aligned  
11 together by a user and where the magnetic field  
12 simply holds the different parts together. A  
13 variety of factors determine the distance at which  
14 the parts will seek together and automatically  
15 locate. These include the strength, shape and type  
16 of magnets used, the presence or absence of pole  
17 pieces, the weight of the suspended female part, and  
18 the length of the pendent upon which the female part  
19 is suspended. Preferred embodiments of the invention  
20 provide for such automatic connection when the parts  
21 120, 150 are at least 2cm apart.

22  
23 The parts 120, 150 also locate automatically due to  
24 the recessed position of the magnet 135 of the male  
25 part 120 behind the wall 139 which prevents the  
26 parts from joining in an offset, non-concentric  
27 manner. Figs 17-19 show concentric and off-set  
28 connections which are possible by a pair of ring  
29 magnets 41, 42 approaching each other at an angle.  
30 Magnets 41, 42, shown in Fig. 17a, produce a  
31 magnetic field or flux attracting oppositely poled  
32 magnets or certain metals towards them. If the

1 attractive force A which would result in a  
2 concentric connection is bigger than the attractive  
3 force B which would result in an offset connection,  
4 then the magnets 41, 42 will connect concentrically.  
5 Conversely, if the attractive force B is greater  
6 than the attractive force A then the magnets will  
7 connect in an offset position, as shown in Figs.  
8 18a, 18b. The attractive force B is only great  
9 enough to cause such offset connection when offset  
10 connection zones 43 of the magnets 41, 42 overlap in  
11 a non-concentric position. Lastly, as shown in Fig.  
12 19a, if the magnet 42 has a wall 44, the magnet 41  
13 is prevented from entering a position where the  
14 attractive force B is greater than that of A and so  
15 the magnets 41, 42 will always connect  
16 concentrically. The provision of the magnet 135 in  
17 a recessed position behind a wall 139 similarly  
18 prevents the parts 120, 150 connecting in an offset  
19 position because the wall 139 prevents the female  
20 part 150 from entering any area where the forces  
21 attracting the parts 120, 150 into an offset  
22 connection are greater than those which attract the  
23 parts 120, 150 into a concentric connection. Where  
24 such walls are provided, the magnets should be able  
25 to exert their magnetic fields beyond the walls in  
26 order to attract the two parts together.  
27  
28 The required height of the walls 139 to prevent off-  
29 set connection depends on the strength, type and  
30 size of the magnets. For example, if the male part  
31 120 has a ring magnet of grade 30 Neo, 22mm outside  
32 diameter, 8mm inside diameter and is 10mm thick, and

1 a female part has a 2:17 grade SmCo female magnet of  
2 23mm outside diameter, 17mm inside diameter and 5mm  
3 thick, the separation between the magnets and the  
4 end of the walls should be at least 3mm.  
5 Alternatively, for a male part 120 with a grade 30  
6 Neo magnet, 20mm outside diameter, 15mm inside  
7 diameter and 5mm thick interacting with the same  
8 female magnet, the separation should be at least  
9 around 5mm. A further alternative is to have the  
10 male 120 and female 150 parts each with grade 30 Neo  
11 magnets 27mm outer diameter, 15mm inner diameter and  
12 1.5mm thickness, the minimum separation would be  
13 around 7mm.

14  
15 As well as ensuring a concentric connection, the  
16 length of the wall 139 should be sufficiently large  
17 to provide a good mechanical connection and resist  
18 accidental disconnection. Moreover, the length of  
19 the wall 139 also affects the influence of the  
20 magnetic flux emitted by the magnet 135 - longer  
21 walls effectively increase the axial attraction  
22 relative to the transverse attraction. Shorter  
23 walls on the other hand effectively increase the  
24 transverse attraction relative to the axial  
25 attraction. Indeed it has been found that more  
26 powerful magnets have a tighter flux and therefore  
27 require smaller walls than some weaker magnets which  
28 have a greater axial attraction. A balance between  
29 axial and transverse attraction is required in order  
30 for the parts to self-seeking and locate together  
31 without the need to be accurately aligned by the  
32 user. Therefore the separation is preferably larger

1 than the minimum required to prevent off-set  
2 connection - around 1cm for preferred embodiments.

3

4 Thus the operation of replacing a light bulb 101 is  
5 far more convenient than those of standard bayonet  
6 or screw thread connections because the more  
7 difficult act of locating the pins of the bayonet  
8 connection of the bulb 101 into the corresponding  
9 sockets or screwing a screw threaded bulb into the  
10 socket is done with hand held components in a  
11 position convenient to the operator rather than the  
12 out of reach or difficult to reach position where  
13 the light bulb 101 is attached and eventually hung.

14

15 Certain embodiments of the invention such as the  
16 connector 100 benefit from the advantage that the  
17 parts 120, 150 may connect together without being  
18 rotationally aligned making the connection even  
19 easier to form.

20

21 Certain embodiments of the invention such as the  
22 connector 100 benefit in that the parts 120, 150 of  
23 the connector 100 locating each other due to the  
24 interacting magnetic fields before securing the  
25 parts together. Therefore where it is difficult to  
26 align the male 120 and female 150 parts (for example  
27 the female part being in a difficult to reach  
28 position) then the operator only has to hold the  
29 male part 120 with attached light bulb 101 in the  
30 vicinity of the female part 150 for the parts to  
31 automatically seek, locate and form an electrical  
32 connection. This is in contrast to forming a

1 bayonet connection which would require bringing the  
2 bulb in line with the socket, rotationally aligning  
3 the bulb with the socket, pressing the bulb and the  
4 socket together and twisting the bulb and socket  
5 with respect to each other before releasing; all in  
6 a position which is difficult to reach. Thus the  
7 use of steps, ladders or chairs in order to gain  
8 access to the out of reach socket/female part 150 is  
9 required less frequently for embodiments of the  
10 invention due to their ease of connection when  
11 compared with known sockets.

12

13 The nature of some ring magnets may make them  
14 susceptible to attract each other and join offset,  
15 in a non-concentric position. However certain  
16 embodiments of the invention, such as the connector  
17 100, benefit in that the magnetic rings cannot  
18 misalign in such a manner because the magnet 165 on  
19 the female part 150 cannot access the magnet 135 due  
20 to the wall 139 unless it locates in a concentric  
21 position. Thus such an advantage further eases the  
22 location of the male 120 and female 150 parts for  
23 certain embodiments.

24

25 A second embodiment of a connector 200 in accordance  
26 with the invention is shown in Figs. 4a-4d, 5a-5c  
27 and 20a-20f. The second embodiment is largely  
28 similar to the first embodiment 100 and like parts  
29 will not be described further. The major difference  
30 with the embodiment described so far is that a male  
31 part 220 part of the connector 200 is in turn

1 connected to any electrical appliance (not shown)  
2 rather than a light bulb 101.

3  
4 Thus embodiments of the invention, such as the  
5 connector 200, have the additional benefit in that  
6 they can provide a socket to a mains supply (not  
7 shown) for use with any type of electrical  
8 appliance, for example buffers, vacuum cleaners or  
9 industrial electrical appliances.

10  
11 The connector 200 comprises a female part 250  
12 suspended from a cable or pendent 203. The male  
13 part 220 being attached to the appliance via a cable  
14 205 may be offered up to the female part 250 and the  
15 respective parts 220, 250 can seek and make a  
16 connection as described for the first embodiment.

17  
18 The male part 220 of the connector 200 also has a  
19 lip 268 on a boss 263 of the female part for close  
20 fitting with an second annular terminal 223 of the  
21 male part 220. The reduced diameter of the  
22 remaining part of the boss 263 compared to that  
23 around the lip 268 allows for the boss 263 to pivot  
24 to a limited extent within the second annular  
25 terminal 223 of the male part 220. Figs. 20a-20f  
26 show the male 220 and female 250 parts of the  
27 connector being assembled and disassembled. The  
28 female part 250 is suspended from a cable 203 and  
29 the male part 220 is brought into its vicinity by a  
30 user 206. The interactive attraction between  
31 respective magnets 235, 365 (not shown in Figs. 20a-  
32 20f) on the male 220 and female 250 parts

1 respectively causes the female part 250 to swing  
2 towards the male part 220 and for the boss 263 to  
3 travel within the male part 220. A tapered surface  
4 (not shown) and walls 239 on the male part help to  
5 guide the boss 263 into the male part 220. As can  
6 be seen from the diagram, the parts 220, 250 connect  
7 at an angle to each other and would do so in most  
8 instances in practice unless the parts 220, 250 are  
9 offered up in axial alignment. Thus the ability to  
10 connect together at an angle is an important feature  
11 of preferred embodiments of the invention. The  
12 reduced diameter of the boss compared with that of  
13 the second annular terminal allows for such angled  
14 connection. The slightly increased diameter at the  
15 lip 268 helps to centre the boss 263 in the second  
16 annular terminal 223. Electrical contacts 221-223,  
17 251-253 and magnets 235, 265 then connect as  
18 described in respect of the first embodiment and as  
19 shown in Fig. 20d. To disassemble the connector  
20 200, a user prises apart the parts 220, 250  
21 typically resulting in the male part 220 being  
22 released from the female part at an angle, since it  
23 is easier to first break the magnetic connection at  
24 one side rather than breaking the whole of the  
25 connection at once. The diameter of the boss 263  
26 also provides for an angled disconnection, Figs.  
27 20e, 20f.

28

29 In common with other preferred embodiments, the  
30 electrical contacts are arranged to connect in the  
31 order: earth, neutral, live and to disconnect in the  
32 order: live, neutral, earth for safe working and to

1 reduce the possibility of sparking or arcing. Even  
2 when connected at an angle, as shown in Figs. 20a-  
3 20f, such an order of connection and disconnection  
4 of the respective terminals is maintained.

5  
6 Optionally the male part 220 could be suspended from  
7 the cable 203 and the female part 250 brought into  
8 its vicinity but this is less preferred since the  
9 live contacts in the male part would be exposed  
10 which may be against safety regulations. Thus an  
11 advantage of certain embodiments of the present  
12 invention is that they are far safer to use than  
13 previous light sockets because the live contacts are  
14 enclosed within the female part and only accessible  
15 through narrow apertures (preferably, less than 3mm  
16 wide).

17  
18 Whereas an earth connection for the first embodiment  
19 of the invention was optional, an earth connection  
20 for the second embodiment is preferred. The  
21 annular earth terminal 223 of the male part is shown  
22 in Figs. 4a, 4b, and is connected to an earth  
23 terminal (not shown) of the appliance via a wire  
24 226.

25  
26 Where an earth connection is provided for the second  
27 embodiment of the invention but not for the first  
28 embodiment of the invention, it is anticipated that  
29 the first embodiment of the invention could have a  
30 face 166 of the magnetic ring 165 of the female part  
31 160 south poled whereas a face 266 of a magnetic  
32 ring 265 of the female part 260 of the second

1 embodiment 200 could be North poled. Corresponding  
2 magnetic rings 136, 236 on the male parts 120, 220  
3 would be oppositely poled so that a male part 220  
4 belonging to the second embodiment 200 and having an  
5 earth connection would connect only to a female part  
6 260 of the same embodiment which also has an earth  
7 connection but be repelled by the female part 160  
8 belonging to the first embodiment of the invention  
9 which has no earth connection. Conversely a male  
10 part 120 belonging to the first embodiment 100 and  
11 having no earth connection would connect only to a  
12 female part 160 of the same embodiment which also  
13 has no earth connection but be repelled by the  
14 female part 260 belonging to the second embodiment  
15 of the invention which has an earth connection.  
16 This would add an extra safety feature to the  
17 connectors 100, 200 to ensure the respective male  
18 parts 120, 220 are connected to the correct female  
19 parts 160, 260 respectively.

20  
21 Third and fourth embodiments of connectors 300, 400  
22 in accordance with the invention are shown in Figs.  
23 6a-6g, Fig. 8 and Fig. 9a-9d respectively. These  
24 embodiments 300, 400 correspond with the first 100  
25 and second 200 embodiments of the invention and  
26 differ in the position and size of magnetic rings  
27 used.

28  
29 The connector 300 comprises a magnetic ring 365  
30 which is embedded in a female part 350 of the  
31 connector 300, as best shown in Fig. 6d. The  
32 magnetic ring 365 is around 5mm in depth. A second

1 magnetic ring 335 is mounted behind a body 330 of  
2 the male part 320 in order to protect the second  
3 magnetic ring 335 from connecting impact damage,  
4 accidental damage or rusting by the body 330 of the  
5 male part 320. A non-magnetic shield 338 is  
6 provided between the magnet 335 and the end of the  
7 male part 320. The magnetic ring 335 is around 10mm  
8 in depth. However, the depth of the magnetic ring  
9 335 may be increased without increasing the size of  
10 annular rings 322, 323 to allow a boss 363 to enter  
11 therebetween. The magnetic ring 365 of the female  
12 part 350 may additionally or alternatively be  
13 embedded within the female part 350 behind a similar  
14 shield (not shown) for the same reasons. In such  
15 embodiments the magnetic rings 365, 335 being  
16 thicker than the corresponding magnetic rings of the  
17 first and second embodiments, can provide a stronger  
18 magnetic field and increase the distance between  
19 which the parts 320, 350 of the connector 300 can  
20 locate each other. Thus when the parts 320, 350 are  
21 in their connected position the magnets will self-  
22 align, as for previous embodiments, but will not  
23 connect face to face due to the shield 338. Fig. 7  
24 shows the connector 300 in its connected position.  
25  
26 The connector 400 also has the thicker magnetic  
27 rings 435, 465. The typical magnetic fields created  
28 by the annular magnets 435, 465 is shown in Fig. 11  
29 and the connector 400 in its connected position is  
30 shown in Fig. 10 and further views are shown in  
31 Figs. 12a-12 & 13.

1 A significant advantage of certain embodiments of  
2 the invention, such as the third and fourth  
3 embodiments, is that the brittle rare earth magnets  
4 are protected by shields making them less liable to  
5 chipping, breakage or other connection impact  
6 damage. Thus, the male 335 and female 365 magnets  
7 will never come into direct contact even when the  
8 parts 320, 350 have connected because they will  
9 remain spaced apart by the shield(s) 338. The  
10 shield(s) 338 may be made from, for example, any  
11 suitable plastic and are also preferably designed to  
12 absorb the high impact shock when the two parts  
13 engage with each other. Although providing shields  
14 338 will reduce the magnetic attraction and strength  
15 of the connection between the magnets 335, 365 it  
16 has been found that this does not prevent the male  
17 and female parts, such as the parts 320, 350,  
18 seeking and locating with each other. Moreover,  
19 less metallic dust or debris will be attracted into  
20 the connector 300, 400 if the magnets are spaced  
21 away from the outer periphery of the parts 320, 350.  
22  
23 The height of the shield 338 should also be taken  
24 into account when determining the necessary height  
25 of walls. Thus, as described above, where a  
26 separation of at least 3mm is required to prevent  
27 the magnets joining in an off-set position, the  
28 walls need only be, for example 2mm, if the shield  
29 is 1mm thick.  
30

1 The magnet 435 is provided in a cartridge 449 (shown  
2 in Figs. 10, 11, 21 and 22) which can be slotted in  
3 and out of the male part 420 of the connector 400.  
4 The cartridge 449 has clips 448 to secure it into  
5 the male part 420. Alternatively a male body 430 of  
6 the male part 420 can comprise a releasable cap (not  
7 shown) which itself comprises walls 439 and a shield  
8 438 which is removable from the rest of the male  
9 body 430 to provide access to the magnet 435. This  
10 can allow for easy cleaning of the connector 400  
11 since any metallic dust or debris which has  
12 collected on the shield(s) 438 will be released  
13 therefrom when the magnet 435 is removed. The  
14 magnet 435 can also be conveniently replaced with  
15 new magnets or magnets of a more suitable strength  
16 for particular applications. Similar cartridges  
17 (not shown) may be used to slot into the female part  
18 450 although cartridges are particularly useful for  
19 the male part 420 as it is more likely to gather  
20 debris because it is normally a hand-held component  
21 whereas the female part 450 which is normally  
22 suspended from a pendent.

23

24 A fifth embodiment 500 in accordance with the  
25 present invention is shown in Figs. 14-16 and  
26 comprises a male part 520 and female part 550. A  
27 comparable connector is disclosed in EP0922426, the  
28 disclosure of which is incorporated herein by  
29 reference. The fifth embodiment is similar to the  
30 first and third embodiments of the invention in that  
31 the male part 520 comprises a portion (not shown)  
32 which is adapted to receive a light bulb and the

1 female part is connected to, and suspended from a  
2 pendent (not shown).

3

4 The male part 520, shown in Fig. 14, comprises a  
5 ring magnet 535, a central pin earth terminal 521,  
6 spring neutral and live terminals 522, 523, and a  
7 cylindrical abutment 532; all housed within an outer  
8 casing 530.

9

10 The female part 550, shown in Fig. 15, comprises a  
11 spring contact finger 551 and annular terminals 552,  
12 553 for respective connection with the terminals  
13 521-523 of the male part 520. The female part also  
14 includes an oppositely poled ring magnet 565, a  
15 shutter 556, a spring 557 and a hollow post 555 with  
16 an aperture 554; all housed within an outer casing  
17 560.

18

19 In use, the female part 550 is suspended by the  
20 cable. The male part 520 is brought into proximity  
21 with the suspended female part 550 and their  
22 oppositely poled magnets 535, 565 attract each  
23 other. This causes a circular shaped bottom face  
24 531 of the abutment 532 to abut with the shutter 556  
25 of the female part 550. The shutter 556 is  
26 depressed into the outer casing 560 of the female  
27 part 550 against the action of the spring 557 by the  
28 attraction of the respective magnetic rings 535,  
29 565. Concurrently, the earth pin terminal 521 moves  
30 through the aperture 554 of the post 555 and  
31 connects with the spring finger 551. As the male  
32 part 520 continues to move into the female part 550,

1 the spring terminals 522, 523 of the male part 520  
2 connect with the annular terminals 552, 553 of the  
3 female part to complete the connection. The  
4 connector 500 is shown in its connected state in  
5 Fig. 16.

6  
7 The provision of a shutter 556 within the female  
8 part 550 encloses the terminals 521-523 within the  
9 female part and thus reduces the likelihood of  
10 electrical shock to a user. Should the shutter 556  
11 be depressed at a single point, then it will move  
12 laterally, pivoting around the point 559 causing a  
13 side wall 558 of the shutter 556 to abut with an  
14 inner face of the casing 560 and so resist further  
15 depression into the female part 550. This ensures  
16 the female terminals 551-553 are not exposed unless  
17 the shutter 556 is depressed at at least two  
18 generally opposite points on its surface.

19  
20 It is clear from the foregoing description that the  
21 earth, neutral and live terminals in any embodiment  
22 may be provided as pins, springs or annular rings.

23  
24 Suspending cables from the ceiling for mains power  
25 supply may be safer than having the cables left  
26 along the floor. Connectors in accordance with the  
27 present invention would provide a straightforward  
28 way in which to connect and disconnect appliances  
29 from such cables. Moreover, should one trip on a  
30 trailing cable the connection would break apart  
31 without damage to the connection and would allow the

1 cable to give under action of the person tripping,  
2 reducing the possibility of injury to that person.

3

4 Certain embodiments of the invention are useful in  
5 areas where electrical power has to be made  
6 conveniently and safely available but out of reach  
7 for Health and Safety reasons. Certain connectors  
8 in accordance with the invention may be used in  
9 areas which need to be cleared quickly such as  
10 hotels, schools or shopping precincts and quickly  
11 connected or disconnected as required or as dictated  
12 by floor movements.

13

14 Embodiments of the invention are also suitable to be  
15 used not only for mains voltages but also for  
16 higher, industrial level voltages, for example of  
17 around 1000Volts.

18

19 Thus it will be appreciated that for certain  
20 embodiments of the invention such as the connector  
21 300 or 400, the magnetic rings need not come into  
22 direct physical connection with each other as they  
23 may be protected, for example, by providing them  
24 within a body of the respective parts in order to  
25 protect them from accidental damage and/or from  
26 rusting. They nevertheless aid the parts' connection  
27 with each other due to the attraction between their  
28 respective magnetic fields.

29

30 Improvements and modifications may be made without  
31 departing from the scope of the invention. For  
32 example, the male (or female) part may be wired to

- 1 any other type of standard connector such as a 2 or
- 2 3 pin plug socket to allow for onward connection to
- 3 appliances having cables with such 2 or 3 pin plugs.